G. E. ALAN DEVER

AN EPIDEMIOLOGICAL MODEL FOR HEALTH POLICY ANALYSIS*

(Received 29 September, 1975)

ABSTRACT. Health programs needing health and other related data have failed in their solutions because they have lacked a rational framework for analysis. A cursory analysis of present disease patterns reveals chronic conditions for which the present system of organized health care has no immediate cures. On the other hand, infectious diseases of decades past have been all but eliminated by vaccines and antibiotics. Before we are able either to prevent or to arrest current disease processes, we must dissect the health field into more manageable elements that reflect a creative area for epidemiological models.

An epidemiological model that supports health policy analysis and decisiveness must be broad, comprehensive, and must include all matters affecting health. Consequently, four primary divisions have been identified: (1) System of Health Care Organization; (2) Life Style (self-created risks); (3) Environment; and (4) Human Biology.

An application of the epidemiological model involves four steps: (1) the selection of diseases that are of high risk and that contribute substantially to the overall morbidity and mortality; (2) to proportionately allocate the contributing factors of the disease to the four elements of the epidemiological model; (3) to proportionately allocate total health expenditures to the four elements of the epidemiological model; and (4) to determine the difference in proportions between (2) and (3) above.

Five tables illustrate how the epidemiological model is applied, showing the diseases selected for analysis; the contributing factors of each disease to the four components of the epidemiological model; the distribution of Federal outlays for medical and health-related activities by category; the distribution of Federal outlays of health expenditures by category; and a comparison of Federal health expenditures to the allocation of mortality in accordance with the epidemiological model.

The conclusion to be drawn from this study is that, based on current procedures for reducing mortality and morbidity, little or no change in our present disease patterns will be accomplished unless we dramatically shift our health policy.

1. INTRODUCTION

The purpose of this paper is to develop an innovative epidemiological model that may be used in policy analysis of health programs [2, 13]. Health programs needing health and other related data have failed in their solutions because they have lacked a rational framework for analysis. A cursory analysis of present disease patterns reveals chronic conditions for which the present system of organized health care has no im-

Social Indicators Research **2** (1976) 453–466.

mediate cures. On the other hand, infectious diseases of the decades past have been all but eliminated by vaccines and antibiotics. Before we are able either to prevent or to arrest the current disease processes, we must dissect the health field into more manageable elements that reflect a creative area for epidemiological models.

It becomes essentially irrelevant how we use health data if we fail to recognize the needs for solution to our disease patterns. Typically, we have correlated, rigorously factored, and canonized data in an effort to squeeze out all meaningful relationships. The results, for the most part, have had questionable utility. Further, we have illustrated data by using graphs, tables, and maps to demonstrate trends, distributions, and patterns. The result of these efforts has increased awareness relative to the magnitude of the problems, but it has not been significantly instrumental in changing disease patterns. We have planned, implemented, and evaluated many health programs only to see efforts expended with little or no reduction of morbidity or mortality. Pure research and clinical investigations certainly have merit, but this approach, when viewed in the overall scheme of current disease patterns, has had a negligible effect in bringing about major disease reduction. The net result of these approaches to disease investigation, prevention, and cure has been the alarming increase of health dollar expenditures with a parallel increase in health problems. For these reasons, our directions need a conceptual framework that allows the health field to be divided into more manageable elements.

Thus, we do not need better data analysis, data presentation, programmatic involvement, and privately dominated research. Rather, we need a new epidemiological approach, using the above concerns in a more meaningful way, one which considers the health field from a different point of view. Such a new epidemiological model will provide a policy analysis that may deal in a more realistic fashion with the current health needs of our population.

2. An Epidemiological Model for Health Policy Analysis

Only recently have we changed our viewpoint about epidemiology and what it involves. This change, however, still falls well below our expectations in terms of how we arrest a disease process.

In 1900, disease was primarily infectious in nature, and major barriers were overcome. In 1975, disease is non-infectious, and major barriers are still existent. Both epidemiological models have severe limitations. First, infectious diseases in the U.S.A. are all but eradicated; therefore the 1900 model is antiquated. Second, chronic diseases of the present do not conform to the present epidemiological model; therefore, the 1975 model is inappropriate.

For these reasons, an epidemiological model for health policy analysis that addresses the problems concerned with changing disease patterns is presented. Breaking the problem of health policy into more manageable segments has been expressed elsewhere [1, 2, 9]. In particular, recent Canadian publications have further elucidated this theme into a health field concept [10, 12].

An epidemiological model that supports health policy analysis and decisiveness must be broad, comprehensive, and must include all matters affecting health. Consequently, four primary divisions have been identified: (1) System of Health Care Organization; (2) Life Style (self-created

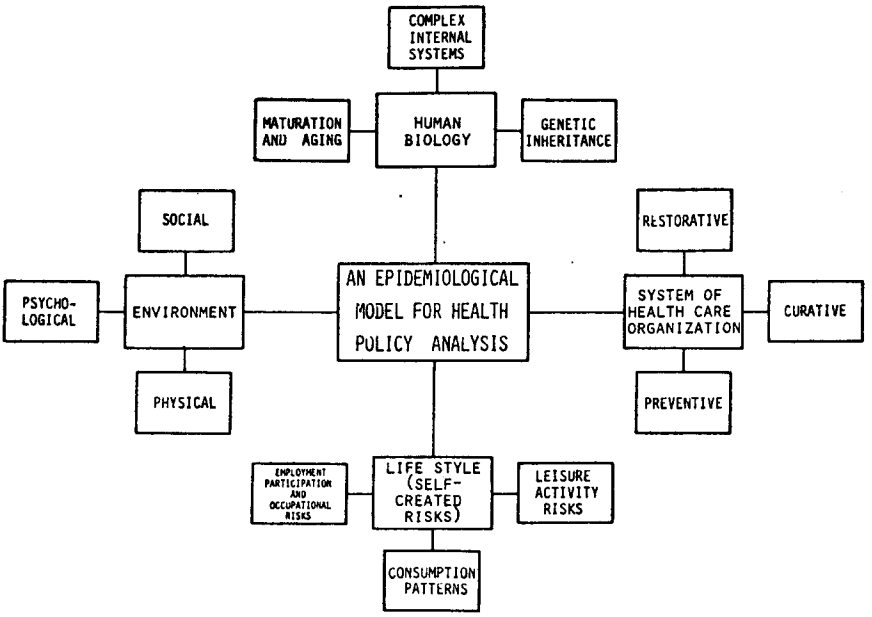

Fig. 1.

risks); (3) Environment; and (4) Human Biology. (Figure 1.) The contention is that this epidemiological model provides a more balanced approach to the development of health policy than the limiting, traditional divisions of prevention, diagnosis, therapy, and rehabilitation; or public health, mental health, and clinical medicine [9]. A closer examination of Figure 1 reveals pertinent subdivisions that allow a more intense investigation of disease.

2.1. *System of Health Care Organization*

A System of Health Care Organization may be divided into three further elements: curative, restorative, and preventive. The primary division – System of Health Care Organization – consists of the availability, quality, and quantity of resources for health care provision. It includes restorative elements – hospital, nursing home, ambulance; curative elements – medical drugs, dental treatment, medical professionals; *and a very limited input in the area of the preventive element.* In the United States, our efforts to improve health and our outlay of expenditures have been directed almost totally toward the System of Health Care Organization. Yet, the morbidity and mortality disease patterns of today are deeply entrenched in the other three divisions of our epidemiological model. Thus, we spend huge sums of money for restoring and curing which should have been earmarked for prevention of disease in the population. Rather than concentrating on the failures of the System of Health Care Organization, it is more advantageous to promote the postitive points of the other three divisions – Life Style, Environment, and Human Biology.

2.2. *Life Style*

Life Styles or, more accurately, *self-created risks*, may be divided into three elements: leisure activity risks, consumption patterns, and employment participation and occupational risks. This division of the epidemiological model consists of the aggregation of decisions by individuals which affect their health and over which they more or less have control [9]. Bad or incorrect decisions result in destructive modes of health that contribute to an increased level of illness or eventual death. Such self-impositions are the result of 'leisure activity risks'. For instance, lack of recreation is strongly associated with hypertension and coronary heart disease. Similarly, lack of exercise aggravates coronary heart disease, leads to

obesity, and results in a total lack of physical fitness. These examples (and there are many more) point out the necessity for focusing more specifically on the other divisions of the epidemiological model. Indeed, it is imperative if we wish to reduce disability and premature death.

Another self-imposed risk is 'consumption patterns'. Here we have: (1) overeating, leading to obesity and subsequent consequences; (2) cholesterol intake, contributing to heart disease; (3) alcohol addiction, leading to cirrhosis of the liver; (4) alcohol consumption, leading to motor vehicle accidents; (5) cigarette smoking, causing chronic obstructive pulmonary disease (chronic bronchitis, emphysema), cancer of the lung, and aggravating heart disease; (6) drug dependency and social drug use, leading to suicide, homicide, malnutrition, accidents, social withdrawal, and acute anxiety attacks; and (7) abundant glucose (sugar) intake, leading to dental caries, obesity, and hypoglycemia with its concomitant problems.

Destructive life styles resulting from 'employment participation and occupational risks' are equally significant but far more difficult to identify. Work pressures lead to stresses, anxieties, and tensions which may cause peptic ulcers and hypertension. Other habits (admittedly difficult to categorize) such as careless driving lead to accidents, while sexual promiscuity often results in syphilis or gonorrhea [12]. Nevertheless, it is the *life-style component* of the epidemiological model which is a major contributing factor to our present disease patterns. It is a component which is viewed with considerable pessimism. The main reason for this 'Achilles' Heel' is self-pleasure. A change in this hedonistic behavior occurs only after a life-death event, and even this wanes considerably as the length of time increases from the onset of the initial event. It is my contention (and it seems obvious) that the consequences of this pleasure principle is that we have, at best, little change and, at worst, no change in the major disease patterns that affect our population [5].

2.3. *Environment*

The environmental element of the epidemiological model may be subdivided into physical, social, and psychological dimensions [4]. The environment is defined as events external to the body over which the individual has little or no control.

In a physical environmental health context, certain hazards show a

close relationship to energy (oil needs) use by an expanding population. Per capita energy consumption is increasing concomitantly with the population and our standard of living. Thus, health hazards will almost assuredly also increase steadily. Such examples include air, noise, and water pollution. Some resulting diseases and/or problems are hearing loss, infectious diseases, gastroenteritis, cancer, emphysema, and bronchitis. In limiting cases, ionizing and ultraviolet radiation have health implications in terms of skin cancer and genetic mutation [16].

The social/psychological division of environmental health encompasses major factors which involve behavior modification, perceptional problems, and interpersonal relationships. Hence, crowding, isolation, rapid and accelerated rate of change, and social interchange may contribute to homicide, suicide, decisional stress, and environmental overstimulation [3, 15]. The health problems relative to the environment will only be rectified by imposing standards and controls on the responsible agencies and industries. Further, the previously stated environmental conditions create risks which are a far greater threat to health than any present inadequacy of the System of Health Care Organization.

2.4. *Human Biology*

The final division of the Epidemiological Model for Health Policy Analysis is Human Biology. This element, focusing on the human body, is a consequence of man's basic biological and organic makeup as an individual. Thus, 'genetic inheritance' of the individual creates genetic disorders, congenital malformations, and mental retardation. The 'maturation and aging' process is a contributing factor to arthritis, diabetes, atherosclerosis, and cancer. Obvious disorders of the skeletal, muscular, cardiovascular, endocrine, and digestive systems can be listed as a subcomponent under 'complex internal systems'. Disease categories relative to Human Biology must be weighted in accordance with the other divisions of the epidemiological model. Genetic counseling of parents with possible Tay-Sachs disease is a step in the right direction. Because, if we can overcome the problems resulting from the human biology of man, then we would be able to save many lives, decrease misery, and reduce the cost of treatment services. This is an obligation to humanity.

The combination of these four divisions – System of Health Care Organization. Life Style, Environment, and Human Biology – into an

Epidemiological Model for Health Policy Analysis has many advantages. Lalonde concludes that the advantages are [10]:

(1) This model raises Life Style, Environment, and Human Biology to a level of categorical importance equal to that of the System of Health Care Organization.

(2) The model is comprehensive – any health problem can be traced to one or a combination of the four divisions.

(3) The model allows a system of analysis by which a disease or pattern may be examined under the four divisions in order to assess relative significance and interaction (i.e., what percentage or proportion of Life Style, Environment, Human Biology, and System of Health Care Organization contributes to suicide?).

(4) This model permits further subdivision of the four major factors; for example, Environment is subdivided into physical, social, and psychological.

(5) This model provides a new perspective on health that creates a recognition and exploration of previously neglected fields.

The intent of the next section of this paper is to apply this concept to the disease patterns in Georgia.

3. An application of the epidemiological model

The application of this model involves four steps: (1) the selection of diseases that are of high risk and that contribute substantially to the overall mortality and morbidity; (2) to proportionately allocate the contributing factors of the disease to the four elements of the epidemiological model; (3) to proportionately allocate total health expenditures to the four elements of the epidemiological model; and (4) to determine the difference in proportions between (3) and (4) above.

For purposes of this study, the top 13 diseases in Georgia were selected for analysis (Step 1). Table I shows the percentage distribution of deaths by age group and by disease. Notably, cancer, heart disease, and stroke rank numbers one, two, and three, respectively, with high-risk groups concentrated in ages over 55. Death due to automobile accidents and other accidents is concentrated in the 15–34 age group. Two other diseases warrant inspection: homicide and suicide. They show concentrations of high risk in the 15–34 and the 35–54 age groups, respectively.

TABLE I

Percentage distribution of deaths by age group for

Cause of mortality (8th revision,

Age group	Total all causes	Diseases of the heart 490–498, 402, 404, 410–429	Cancer 140–209	Cerebro-vascular 430–438	Motor vehicle accidents E810–E823	All other accidents E800–E807, E825–E849	Influenza and pneumonia 470–474, 480–486
All Ages	43910	14922	6532	5897	1847	1657	1648
Percent of total deaths	100.0	34.0	14.9	13.4	4.2	3.8	3.8
Percent of deaths for each disease	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Under One	3.7	0.1	0.1	0.0	0.9	4.6	11.6
One–Four	0.8	0.1	0.4	0.1	3.4	5.3	2.2
Five–Fourteen	1.1	0.1	0.8	0.1	8.0	7.5	0.8
Fifteen–Twenty-four	3.2	0.2	1.0	0.4	28.2	14.5	1.6
Twenty-five–Thirty-four	3.4	0.7	1.6	0.8	17.5	12.6	2.1
Thirty-five–Forty-four	5.1	2.8	4.6	2.3	11.9	10.6	4.7
Forty-five–Fifty-four	10.6	9.6	14.5	6.2	10.4	12.3	8.4
Fifty-five–Sixty-four	18.4	20.3	26.8	14.1	9.4	11.5	11.4
Sixty-five–Seventy-four	22.2	28.2	28.1	25.9	6.7	8.6	18.9
Seventy-five and over	30.5	37.8	22.2	50.1	3.7	12.6	38.2

Source: Georgia Department of Human Resources
Division of Physical Health
Health Services Research and Statistics
Compiled by Anne A. Caldwell

Thus, the major cripplers and killers of Georgia represent multiple age groups in terms of high risk and multiple etiologies in terms of determining preventive measures.

Utilizing the 13 selected diseases, the second step involves allocating, in a proportional sense, the contributing factors of each disease to the four components of the epidemiological model. Table II clearly depicts that the major contributing factors to the selected diseases are deeply rooted in Life Style, Environment, and Human Biology. It also indicates that the System of Health Care Organization has limited impact with

Selected important causes of mortality in Georgia, 1973

international classification of diseases)						
Diseases of the respiratory system 460–466, 490–493, 500–519	Diseases of the arteries, veins and capillaries 400–448	Homicides E960–E969	Birth injuries and other diseases peculiar to early infancy 760–779	Diabetes mellitus 250	Suicides E950–E959	Congenital anomalies 740–759
1179	1120	985	834	772	630	351
2.7	2.6	2.2	1.9	1.8	1.4	0.8
100.0	100.0	100.0	100.0	100.0	100.0	100.0
2.4	0.2	0.5	99.8	0	...	66.4
0.9	0	0.7	0.2	0	...	10.0
0.6	0.1	1.3	0	0.1	0.8	6.3
0.8	0.1	22.8	0	0.5	15.6	4.0
2.0	0.2	26.9	0	1.9	17.0	3.1
2.6	2.1	21.2	0	3.5	19.0	3.4
9.4	4.3	13.0	0	11.0	22.1	1.4
22.6	12.2	9.2	0	22.0	14.4	2.3
30.4	23.7	2.9	0	34.5	7.8	2.3
28.2	57.1	1.3	0	26.4	3.3	0.9

respect to disease prevention. (We seem to be locking the gate after the horse has galloped away.) The allocation of diseases to the four categories was achieved through input from various lay and professional individuals. Recognizing that the analysis in Table II is subjective and, in most instances, judgmental, it does, however, agree with the majority of medical literature [6, 7, 11]. This step allows programmatic areas which deal with specific diseases to set priorities and to decide upon health policy. This type of health policy analysis may reveal gaps in the delivery of our health services. Undoubtedly, further expectations related to reduction of

TABLE II

An epidemiological model for health policy analysis – disease evaluation

Percent distribution of total deaths [a]	Cause of mortality (8th revision, international classification of diseases)	Percentage allocation of mortality to the epidemiological model [b]			
		System of health care organization	Life style	Environment	Human biology
34.0	Diseases of the heart (390–398, 402, 404, 410–429)	12	54	9	28
14.9	Cancer (140–209)	10	37	24	29
13.4	Cerebrovascular disease (430–438)	7	50	22	21
4.2	Motor vehicle accidents (E810–E823)	12	69	18	0.6
3.8	All other accidents (E800–E807, E825–E849)	14	51	31	4
3.8	Influenza and pneumonia (470–474, 480–486)	18	23	20	39
2.7	Diseases of the respiratory system (460–466, 490–493, 500–519)	13	40	24	24
2.6	Diseases of the arteries, veins, and capillaries (400–448)	18	49	8	26
2.2	Homicides (E960–E969)	0	66	41	5
1.9	Birth injuries and other diseases peculiar to early infancy (760–779)	27	30	15	28
1.8	Diabetes mellitus (250)	6	26	0	68
1.4	Suicides (E950–E959)	3	60	35	2
0.8	Congenital anomalies (740–759)	6	9	6	79
	Percent allocation – average	11	43	19	27

[a] 1973.

[b] Due to rounding, the percent allocations may not add to 100%.

Source: Author.

mortality will only occur if the health program is proportionately directed toward each element of the epidemiological model.

In 1974, 29.2 billion dollars were spent for health by the Federal government. This amount is estimated to increase to 35.0 and 37.7 billion dollars for 1975 and 1976, respectively [14]. Table III shows the distribution of Federal outlays of health activities by category. In its present form, the table provides very little information in terms of the proposed Epidemiological Model for Health Policy Analysis. For this reason, Table IV was formulated to correspond to the four elements of the epidemiological model. Notably, the majority of expenditures by the Federal government is allocated to the category of System of Health Care Organization – average, 90.6%. The elements of Human Biology, Environment, and Life Style account for an average of 6.9%, 1.2%, and 1.5%, respectively [18].

TABLE III

Federal outlays for medical and health-related activities by category (in millions of dollars)

Health programs	Outlays		
	1974 actual	1975 estimate	1976 estimate
Development of health resources, total	4383	5242	5362
Health research	2085	2424	2512
Training and education	1146	1324	1145
Construction	761	967	1108
Improving organization and delivery	392	527	596
Provision of hospital and medical services, total	23918	28783	31348
Direct federal services	4797	5390	5828
Indirect services	19120	23393	25520
Prevention and control of health problems, total	888	1019	989
Disease prevention and control	419	458	405
Environmental control	90	129	137
Consumer protection	378	432	446
Total, health programs	29189	35044	37699

Source: Adapted from federal health programs, office of management and budget, special analysis K, budget of the U.S. Government, 1976, p. 169.

TABLE IV

Allocation of federal health expenditures in accordance with the epidemiological model for health policy analysis, 1974, 1975, and 1976

Elements of the epidemological model for health policy analysis	Federal outlay (in millions)		
	1974 (actual)	1975 (estimate)	1976 (estimate)
Total federal health expenditures	29189	35044	37699
Systems of health care organization	26216	31601	34197
Training and education	1146	1324	1145
Construction of health care facilities	761	967	1108
Improving organization and delivery	392	527	596
Provision of hospital and medical services	23918	28783	31348
Direct federal service	4797	5390	5828
Indirect services	19120	23393	25520
Percent of total federal health expenditures	89.8%	90.1%	90.7%
Life style	420	458	405
Disease prevention and control	420	458	405
Percent of total federal health expenditures	1.4%	1.3%	1.1%
Environment	468	561	583
Environmental control	90	129	137
Consumer safety	378	432	446
Percent of total federal health expenditures	1.6%	1.6%	1.5%
Human biology	2085	2424	2512
Health research	2085	2424	2512
Percent of total federal health expenditures	7.1%	6.9%	6.7%

Source: Author.

Finally, a comparison of Tables II and IV shows a disproportionate amount of money allocated for the System of Health Care Organization, when the means for reducing mortality and morbidity are deeply rooted in Life Style, Environment, and Human Biology elements, with only minimal reductions in mortality and morbidity expected from the System of Health Care Organization (Table V). The conclusion is obvious. Based on current procedures for reducing mortality and morbidity, it is clear that unless we dramatically shift our health policy we will see little or no change in our present disease patterns. In fact, with our aging population

TABLE V

Comparison of federal health expenditures to the allocation of mortality in accordance with the epidemiological model for health policy analysis

Epidemiological model for health policy analysis	Federal health expenditures 1974–76 (percentage)	Allocation of mortality to the epidemiological model (percentage)
System of health care organization	90.6	11
Life style	1.2	43
Environment	1.5	19
Human biology	6.9	27
Total	100.2[a]	100%

[a] Due to rounding.

Source: Author.

we might very well see dramatic increases in mortality and morbidity.

The question that remains to be answered is, "How do we change our short range, hedonistic model so that diseases resulting from Life Styles may be significantly altered or reduced?" Some possibilities that have been offered are social health marketing and social engineering [8, 17]. Whatever approach is utilized, the problems to overcome will be paramount. Nevertheless, the humanitarian challenge is one that may well be difficult to equal.

Health Services Research and Statistics, Division of Physical Health, Georgia Department of Human Resources

NOTE

* The completion of this paper was dependent upon direct staff support in the Health Services Research and Statistics Section. I wish to thank Judy Morris and Geneva Hopkins for their stenographic skills as well as Anne Caldwell and Michael Lavoie for their statistical expertise.

REFERENCES

1. Blum, H. L.: 1974, *Planning for Health – Development and Application of Social Change Theory*, Human Sciences Press, New York, N.Y.

2. Burt, M. R.: 1974, *Policy Analysis – Introduction and Application to Health Programs*, Information Resources Press, Washington, D.C.
3. Cullingworth, J. B. (ed.): 1973, *Problems of an Urban Society, Vol. 3, Planning for Change*, University of Toronto Press, Toronto, Ontario, Canada.
4. Dever, G. E. A.: 1974, *Dimensions of Environmental Health*, paper presented at the Georgia Public Health Association.
5. Dever, G. E. A.: 1974, *The Future of Health Services in Georgia*, paper presented at a Workshop on Change, Armstrong State College, Savannah, Georgia.
6. Erhardt, C. L. and Berlin, Joyce E. (eds.): 1974, *Mortality and Morbidity in the U.S.*, Vital and Health Statistics Monographs, American Public Health Association, Harvard University Press, Cambridge, Mass.
7. Hunter, J. M. (ed.): 1974, *The Geography of Health and Disease*, Papers of the First Carolina Geographical Symposium, Dept. of Geography, University of North Carolina, Chapel Hill, N.C.
8. Kotler, P. and Zaltman, G.: 1971, 'Social Marketing: An Approach to Planned Social Change', *J. Marketing* **35**, 3–12.
9. La Framboise, H. L.: 1973, 'Health Policy: Breaking the Problem Down into more Manageable Segments', *J. Can. Med. Assoc.* **108**, 388–393.
10. Lalonde, M.: 1974, *A New Perspective on the Health of Canadians*, Office of the Canadian Minister of National Health and Welfare, Ottawa.
11. Lillefeld, A. M. and Gifford, A. J. (eds.): 1966, *Chronic Diseases and Public Health*, The Johns Hopkins Press, Baltimore.
12. Minister of Industry, Trade, and Commerce, Office of the Senior Advisor on Interpretation, Statistics Canada: 1974, *Perspective Canada: A Compendium of Social Statistics*, Information Canada, Ottawa.
13. Newell, K. W.: 1975, 'Public Health Research: Possibilities and Opportunities', *W.H.O. Chronicle* **29**, 3–5.
14. *Special Analyses, Budget of the United States Government, 1976, Federal Health Programs, Special Analysis K.* Office of Management and Budget, February 1975, p. 169–196.
15. Toffler, A.: 1970, *Future Shock*, Random House, Inc., A Bantam Book, New York, N.Y.
16. U.S. Dept. of H.E.W.: 1970, *Man's Health and the Environment – Some Research Needs*, Report of the Task Force on Research Planning in Environmental Health Sciences. U.S. Government Printing Office, Washington, D.C.
17. Zaltman, G. and Vertinsky, I.: 1971, 'Health Service Marketing: A Suggested Model', *J. Marketing* **35**, 19–27.
18. Fiscal data as illustrated in Table III is not available for Georgia; therefore, the U.S. fiscal data is utilized.